

# A New Species of *Okenia* (Nudibranchia: Doridacea) from the Peruvian Faunal Province

by

SANDRA V. MILLEN

Department of Zoology, University of British Columbia, Vancouver, B.C., Canada V6T 1Z4

MICHAEL SCHRÖDL

Zoologisches Institut, Ludwig Maximilian University, München, Germany<sup>1</sup>

NELLY VARGAS

Invertebrate Zoology Laboratory, Ricardo Palma University,  
P.O. Box 2075, Lima 1, Peru<sup>2</sup>

AND

ALDO INDACOCHEA

Invertebrate Zoology Laboratory, Ricardo Palma University,  
P.O. Box 2075, Lima 1, Peru

*Abstract.* A new species of *Okenia*, with a smooth dorsum, white body, and yellow markings, has been found in Peru and Chile in the shallow subtidal. This species is described and compared to similar species worldwide. This is the first record of the genus from the Peruvian faunal province.

## INTRODUCTION

The eastern South Pacific opisthobranch fauna of the Peruvian province is poorly known. The first report was that of Lesson (1831) who briefly described and figured *Aeolidia lottini* from Talchuano, Chile, near the southern end of the Peruvian faunal province. Of greater impact were the descriptions and excellent drawings of d'Orbigny (1835-1846) of 14 new species of opisthobranchs from the coast of Peru and Chile. These works were followed by Couthouy's manuscript descriptions of three species from central Chile, published by Gould (1852), which are inadequate for proper identification. Bergh (1873) described an aeolid,

*Aeolidia serotina*, collected by Professor Kroyer and deposited in the Copenhagen Museum. Bergh (1898) described 10 additional species which had been collected by L. Plate in Chile. Dall (1908) described *Scaphander cyllindrellus* from Callao, Peru. Odhner (1921) added *Aeolidia collaris* and *Cadlina sparsa* from Juan Fernández Island. The latter species has subsequently been reported as far north as San Francisco, California. The last opisthobranch researcher to visit the Peruvian faunal province was Ernst Marcus (1959), who described a sacoglossan, *Aplysiopsis brattstromi*, from northern Chile and another nine new species from the Gulf of Ancud, an area of faunal overlap just south of the 41°S boundary of the Peruvian and Magellanic faunal provinces. This description of a new species of *Okenia* Menke, 1830 is the first description of a new species of opisthobranch from the Peruvian faunal province since 1959 and the first report of the genus *Okenia* from the eastern coast of the South Pacific.

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<sup>1</sup> Present address: Eisenhartstrasse 64, 81245 München 60, Germany.

<sup>2</sup> Present address: Departamento de Zoología, Universidad de Concepción, Casilla 2407, Apartado 10, Concepción, Chile.



Figure 1

*Okenia luna* Millen, Schrödl, Vargas & Indacochea, sp. nov.  
 Drawn from a photograph of a living specimen.

SYSTEMATICS

Family GONIODORIDIDAE  
 H. & A. Adams, 1854

Genus *Okenia* Menke, 1830

*Okenia luna* Millen, Schrödl,  
 Vargas & Indacochea, sp. nov.

(Figures 1–9)

**Etymology:** The rounded shape and pale white and yellow coloration suggested the Latin (and Spanish) word for moon.

**Material:** Holotype: California Academy of Sciences CAS-IZ 089293, 1 specimen, 7 mm long. Collected by Michael Schrödl on 17 April 1992; Bay of Coliumo, just north of Concepción, central Chile (36°32'S, 73°57'W), at 12 m depth on the alga *Gracilaria chilensis* Bird, MacLachlan & De Oliveira, 1987, covered with hydroids and the bryozoan *Alcyonidium nodosum* O'Donoghue & de Waterville, 1944.

Paratypes: CASIZ 089294, 4 specimens, 5–7 mm long. Collected by M. Schrödl on 2 May 1992 at the type locality, 12 m depth on the alga *Gracilaria* and on *Nassarius* shells on a muddy sand bottom.

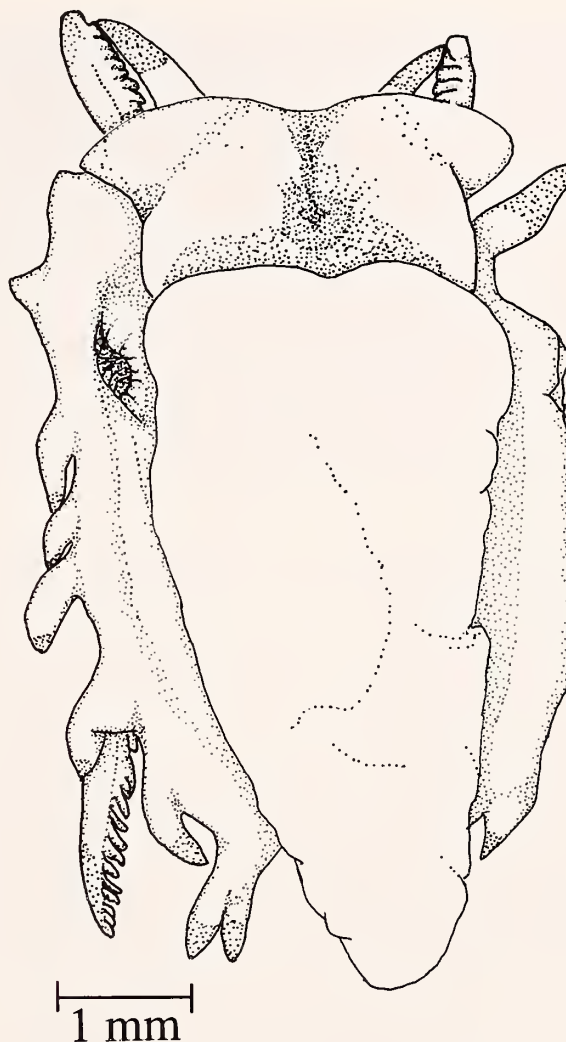


Figure 2

*Okenia luna* Millen, Schrödl, Vargas & Indacochea, sp. nov.  
 Camera lucida drawing of the ventral view of a preserved specimen.

University of San Marcos, Lima, Peru, 1 specimen, 3.5 mm long, in the collection of Dr. Carlos Paredes. Collected on 5 May 1987 on algae at Ancón, Peru (11°47'S, 77°11'W).

Museo de Historia Natural de la Universidad Ricardo Palma, Lima, Peru, RPT 112–117, 6 specimens, 4.5–10 mm long. Collected by Aldo Indacochea on 30 November 1993; Ancón, Peru, 3 m depth on the algae *Gracilariopsis* and *Ulva* encrusted with bryozoans.

Museo Zoológico de la Universidad de Concepción, Concepción, Chile MZUC 22522, 1 specimen, 7 mm long. Collected by M. Schrödl on 2 May 1992 at the type locality, 12 m depth on the alga *Gracilaria*.

Additional material: One specimen collected in Ancón, Peru on 30 June 1988 was dissected. One hundred and

twenty-one living specimens were observed from March to May, 1992 in the Bay of Coliumo, Chile, and five were dissected.

**Description:** *External morphology:* The living animals are 5–12 mm long, 3–5 mm wide, and 2.5–5 mm high, with a mean length of 8.4 mm ( $n = 127$ ). They are elongate oval in shape (Figure 1), with an overhanging mantle rim 1 mm wide. The mantle rim has 7–12 simple, 1–1.5 mm long, digitiform processes per side. In living animals, these usually curl upward. Anteriorly the overhanging rim is discontinuous. The first process on each side is anterior to the rhinophores, and projects anteriorly. The two most posterior processes on each side are longer than those on the sides and join at their bases, sometimes fusing along most of their length with only the tips separate.

The dorsum is smooth, with neither crests nor tubercles. When contracted, it appears slightly pustulose. The mantle processes do not contain obvious spicules. The rhinophores, which are curved back over the dorsum in living animals, are up to 3 mm long. They bear 10–15 perfoliate lamellae which meet in a chevron on the posterior surface. Anteriorly they are smooth, and they end in a blunt tip.

The 7–11 (usually nine) simply pinnate gills are arranged in a wide semicircle around a small central anal opening. The renal pore is to the right of the anus. The gills are larger anteriorly, up to 2.5 mm long; the posteriormost are sometimes very small. They are irregularly laminate with 16–20 lamellae per side, positioned toward the interior edge. The basal third of the central rachis contains internal branchial glands.

The head (Figure 2) is in the form of a bilobed velum. The tentacles are broad, flattened triangles extending laterally and not demarcated from the head. The foot is straight or slightly indented in the midline, but unnotched anteriorly. The anterolateral corners are rounded, and the entire foot tapers to a rounded, leaflike tail. The foot flange is 0.5 mm wide and is hidden by the mantle rim. The tail projects up to 1.5 mm beyond the body wall.

The ground color of the body is hyaline white. The mantle processes are yellow on the outer half, ending in clear tips. There is a broad mid-dorsal stripe made up of yellow spots, starting behind the rhinophores and ending before the gills. There is a lateral yellow line between the anteriormost mantle processes, sometimes connecting as a

yellow streak across the entire front of the mantle margin, occasionally reduced to a wide lateral dash or triangle in the center. In a few specimens, the yellow spots on the mantle are replaced wholly or partially by opaque white. The rhinophores have hyaline white bases and pale cream leaves. Opaque white pigment extends from the tips down the central rachis about one-fourth of its length and occasionally is extended to the mid-rhinophore region by yellow pigment. It is more obvious on the anterior where it is not obscured by the leaves of the rhinophores. The gills are hyaline white with a yellow streak one-half to two-thirds of the way down from the tip on the outer side. The sides, foot, and head are hyaline white, usually without pigment, although a few of the 127 specimens examined have an interrupted medial opaque white line on the tail.

*Digestive system:* The short buccal tube is surrounded on the lateral and ventral surface by simple labial glands. The round lip disc (Figure 3) has two ventral flaps and two ventral semicircular areas composed of rectangular scales, 6.2–9.6  $\mu\text{m}$  long, which have four to six serrations on the outer edges (Figure 4). The buccal bulb has a large, cuticle-lined, sucking crop consisting of two muscular pouches with a median muscular strap between them. A short radular sac projects posteriorly from the ventral surface of the buccal bulb.

The radular formula is 23–27 (1.1.0.1.1). The lateral teeth have a rounded base and a long, almost straight, denticulate hook set nearly at right angles to the base (Figures 5, 6). The hook bears 12–36 denticles on the inner surface (Figure 7). At the inner base of the hook is a small knoblike projection (Figure 5). The lateral teeth have bases 0.06–0.11 mm long and hooks 0.08–0.12 mm long. The marginal teeth are small oval plates with one small hook (Figure 8). They reach a height of 0.03–0.09 mm.

The esophagus is long, tubular, and thin-walled. On either side of the esophagus is a small, flattened, oval, granular salivary gland which attaches to the buccal bulb by a thin duct. The esophagus enters the base of the vertical, oval stomach, which is anterior to the digestive glands and lacks a caecum. The digestive glands are confluent, oval except for the anterior right depression of the reproductive system, and pinkish in preserved specimens. Dorsally they are covered by the cream-colored ovotestis. The intestine exits at the upper right of the stomach in a wide

#### Explanation of Figures 3 to 8

Figure 3. Lip disc. SEM micrograph showing the ventral flaps and the scale pattern in the ventral left quadrant. Scale bar = 40  $\mu\text{m}$ .

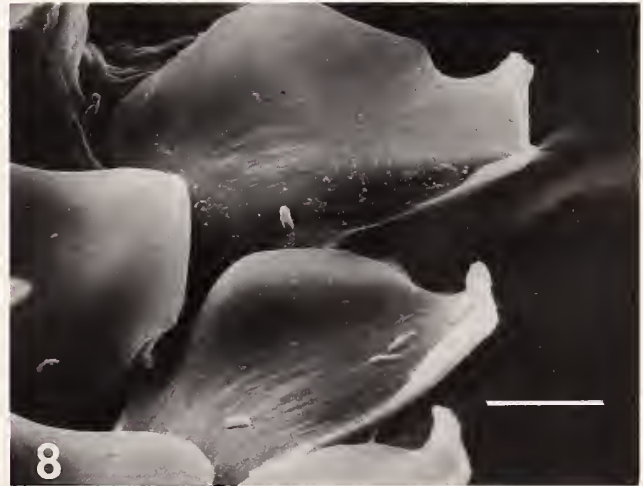
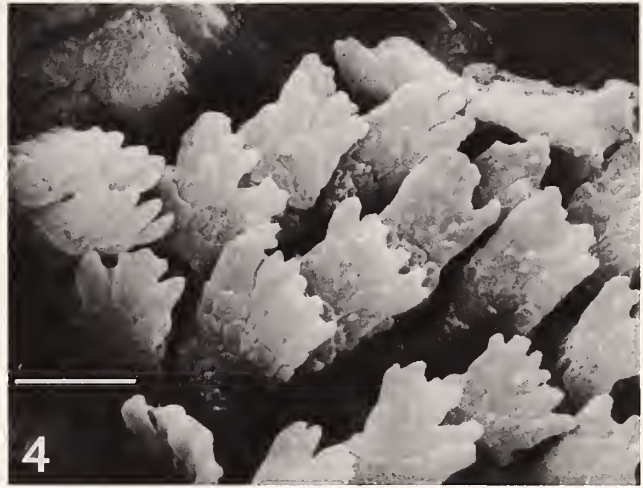
Figure 4. Close-up of lip scales showing the serrated edge. Scale bar = 5  $\mu\text{m}$ .

Figure 5. Lateral radular teeth from a half row. Scale bar = 20  $\mu\text{m}$ .

Figure 6. Lateral and marginal teeth. Scale bar = 20  $\mu\text{m}$ .

Figure 7. Close-up of denticles on the lateral teeth. Scale bar = 2  $\mu\text{m}$ .

Figure 8. Marginal teeth. Scale bar = 10  $\mu\text{m}$ .



curve and travels on the right side of the digestive gland. Posteriorly it loops to the left to end at the anus in the center of the branchial semicircle. The anal tubercle is low.

**Central nervous system:** The cerebropleural ganglia are completely fused and joined by a short connective duct. The small rhinophoral ganglia are connected anteriorly by a short stalk. The eyes are on short stalks. A right visceral ganglion is present. The round pedal ganglia are smaller than the cerebropleurals and are located slightly posterior and ventro-lateral to them. They are connected to the cerebropleurals by a very short commissure and to each other by a slightly longer pedal commissure. The paired, oval buccal ganglia lie close together under the esophagus and each has a gastro-esophageal ganglia attached by a short anterior stalk.

**Reproductive system (Figure 9):** The ovotestes cover the surface of the digestive gland, and the round female lobules are peripheral to the male ducts. There are two major longitudinal collecting ducts which unite to form the long thin preampullar duct, beginning just to the right of the esophagus. This duct widens into a curved, tubular ampulla which runs across the dorsal surface and down the anterior face of the female gland mass. The ampulla divides into a short oviduct which enters the fertilization chamber and the vas deferens. The vas deferens travels dorsally a short distance, then loops anteriorly, widening into a long, tubular prostatic portion which proceeds inwardly and then loops back on itself. It constricts into a thin, tubular muscular portion which is about one-half the length of the prostate. The distal half of the muscular vas deferens is inside a thin penial sheath, which enters a short eversible, conical praeputium. The tip of the vas deferens is armed for 0.135 mm with approximately eight rows of small spines with round bases, 4.5–6  $\mu\text{m}$  long.

The vagina is slightly expanded near its opening posterior to the penis. It is a straight, thin cylindrical tube. It ends in a three-way junction with the ducts from the bursa copulatrix, receptaculum seminis, and the insemination duct, which are vaginally arranged. The duct to the bursa copulatrix is short, wide, and in line with the vagina. The bursa copulatrix is large and circular, the inner sac is dark brown. The duct to the receptaculum seminis runs distally alongside the vagina then curves back on itself to form a small, elongate receptaculum seminis. The insemination duct also runs parallel to the vagina a short distance before crossing the female gland mass and entering the fertilization chamber at the anterior end of the albumen gland. The fertilization chamber is round and swollen with sperm, with an elongate caecum projecting into the mucous gland. The oviduct enters the albumen gland from the round portion next to the entrance of the insemination duct. The female gland mass has a large, granular, oval anterior albumen gland, a highly convoluted mucous gland, which is ventral to the albumen gland, and a small, oval membrane gland ventral and distal to the albumen gland. The exit duct is wide and ventral to the

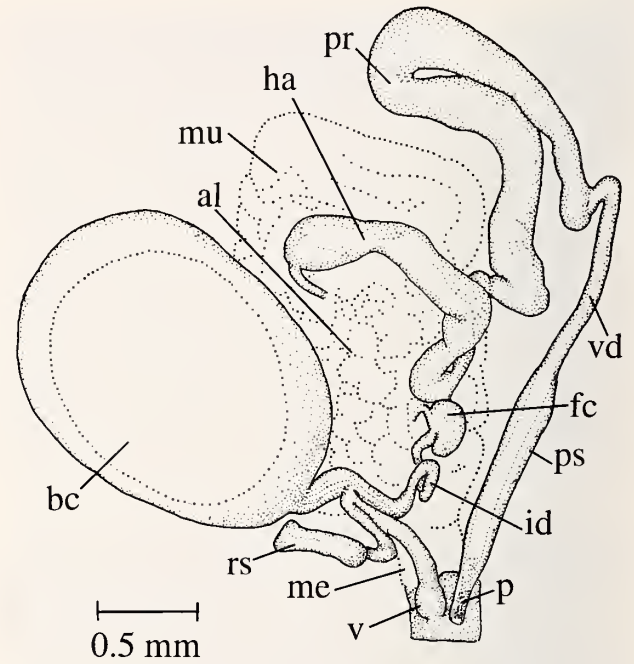


Figure 9

*Okenia luna* Millen, Schrödl, Vargas & Indacochea, sp. nov. Reproductive system drawn using a camera lucida. Key: al—albumen gland; bc—bursa copulatrix; fc—fertilization chamber; ha—hermaphroditic ampulla; id—insemination duct; me—membrane gland; mu—mucus gland; p—penis; pr—prostate; ps—penis sheath; rs—receptaculum seminis; v—vagina; vd—vas deferens.

vagina. The genital openings are located close to the notum on the right side just posterior to the front of the foot, in the anterior one-third of the body.

**Ecology:** *Okenia luna* occurs at 3–20 m depth on a variety of substrates; rock walls, mud, and sand bottoms where they are usually on *Argopecten purpuratus* (Lamarck, 1819) shells, *Nassarius* shells, polychaete tubes (*Diopatra* sp.) and algae. These hard substrates were encrusted with the bryozoan *Alcyonidium nodosum*. The nudibranchs were observed feeding on this bryozoan in the laboratory.

*Okenia luna* has been found in the months of May, June, September, November, and December in central Peru, and from March to May in central Chile, with a sudden disappearance of this species in late May. In mature specimens from Chile, 70 percent have parasitic copepods. Spawn masses were found in December in Ancón, Peru, and in May in central Chile. Spawning appears to be a gregarious behavior; up to 51 specimens laid over 100 spawn masses on three small algal plants within a 15 m-square area. The spawn masses are cream-colored, sausage-shaped strings with  $\frac{3}{4}$  to  $2\frac{1}{2}$  whorls, approximately 5 mm in diameter. There is one egg per capsule, with a preserved diameter of 90–100  $\mu\text{m}$ . Eggs hatch in 8–11 days at 15–16°C into free-swimming veligers.

The known range of *Okenia luna* is from Ancón, Peru (11°47'S, 77°11'W) to the Bay of Coliumo, near Concepción, central Chile (36°32'S, 73°57'W).

## DISCUSSION

This new species of *Okenia* belongs to the group which Bergh (1881) called *Idaliella*. *Idaliella* was characterized by a smooth dorsum, lacking medial notal appendages, and an oral armature consisting of two bands of scalelike armature as opposed to a ring of hooks. Ernst Marcus (1957) pointed out that there are exceptions to the labial armature, with *Okenia impexa* Marcus, 1957 having a smooth ring, and *O. echinata* Baba, 1949 having two bands of armature instead of a complete ring. On this basis, he suggested that the genus *Idaliella* be considered a subgenus. We agree with Robert Burn (1971) that *Idaliella* is not sufficiently distinct and should be regarded as a subjective junior synonym of *Okenia*.

Only three or four of the currently recognized 24 or 25 species of *Okenia* have a smooth notum and two bands of labial armature. Three of these, unfortunately, have their synonymy in dispute. *Okenia quadricornis* (Montagu, 1815), the oldest nominal species, is poorly described and could be a senior synonym to either *O. aspersa* (Alder & Hancock, 1845), or *O. pulchella* (Alder & Hancock, 1854), or both (see Schmekel & Portmann, 1982; Just & Edmunds, 1985; Thompson, 1988). Further confusion has arisen because *Okenia aspersa* apparently can have either a smooth notum or one small mid-dorsal appendage (Just & Edmunds, 1985; Cervera et al., 1991). All of these species can be separated from *Okenia luna* on the basis of their reddish-brown coloration, high subquadrate bodies, and large frontal velum. Three other species, *Okenia amoenula* (Bergh, 1907), *O. mediterranea* (Von Ihering, 1886), and *O. sapelona* Marcus & Marcus, 1967 are similar in shape to *O. luna*, and also have pale bodies with yellow on the notal processes, dorsum, and gills.

*Okenia luna* can be separated from *O. amoenula* externally by the red pigment which is prominent on the dorsum, gills, tail, mantle processes, and sides of *O. amoenula* (see Gosliner, 1987:fig. 158) and by the wider branchial cirlet of *O. luna*. Internally, the scales on the lip disc are larger, smooth, and more elongate in *O. amoenula* (to 0.25 mm vs. 0.001 mm), and there are more radular tooth rows (32–35 vs. 23–27) (Bergh, 1907). According to MacNae (1958), the reproductive bursae are semi-serially arranged in *O. amoenula*. They are vaginal in *O. luna*, and the receptaculum seminis is much smaller and more elongate, with a longer stalk.

*Okenia mediterranea* differs from *O. luna* in its possession of a low median keel-shaped crest with four to five small tubercles and in having two to four small lateral tubercles in a line on each side of the central crest (Cervera et al., 1991). *Okenia mediterranea* is usually colored with both yellow and light-red pigment, giving it an orange color,

but a few individuals have only yellow (Cattaneo-Vietti et al., 1990: pl. 1, fig. 3). The yellow pattern described by Schmekel (1979) varies from that of *O. luna*, which lacks yellow on the sides of the notum and tail. The reproductive system described by Cervera et al. (1991) differs from that of *Okenia luna* in that the ampulla is much shorter, the bursae are serially arranged, and the seminal receptacle is larger and oval in shape, with a short duct. In addition, the prostate is shorter and wider, and the albumen gland smaller in *Okenia mediterranea*.

*Okenia sapelona* is similar to *O. mediterranea* in its possession of a low central crest of five small tubercles and two pairs of lateral tubercles on each side (Marcus & Marcus, 1967). This distinguishes it from the smooth medial notum of *Okenia luna*. *Okenia sapelona* differs also in color, the ground being iridescent pale blue, and the gills and rhinophores having maroon spots. The yellow pattern is spread over the sides of the notum, tail, sides, and top of the head, places where it is absent in *Okenia luna*. The gill cirlet is much smaller in *Okenia sapelona* than in *O. luna*. Internally, *Okenia sapelona* has a complete labial cirlet with smooth octagonal plates which are conical in side view (Marcus & Marcus, 1967), not the rectangular plates with serrated edges found in *O. luna*. It has fewer radular teeth (12 vs. 23–27). The reproductive system has serially arranged bursae, and the receptaculum seminis is larger and more oval than that found in *Okenia luna*. It is possible, from the external similarities and the reproductive features, that *Okenia sapelona* from Georgia, in the western North Atlantic, and *O. mediterranea* from the Mediterranean Sea may prove to be conspecific and amphiatlantic in their distribution.

## ACKNOWLEDGMENTS

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## LITERATURE CITED

- BERGH, L. S. R. 1873. Beiträge zur kenntniss der Aeolidiaden 1. Verhandlungen der königlich kaiserlich zoologisch botanischen Gesellschaft in Wien 23:597–628. pls. 7–10.
- BERGH, L. S. R. 1881. Ueber die Gattung *Idalia* Leuckart. Archiv für Naturgeschichte 47:140–181. pls. 6–8.
- BERGH, L. S. R. 1898. Die Opisthobranchier der Sammlung Plate. Zoologischer Jahresbericht Suppl. 4(3). Fauna Chilensis vol. 1:481–582. pls. 28–33.
- BERGH, L. S. R. 1907. The Opisthobranchiata of South Africa.

- Transactions of the South African Philosophical Society 17: 1-144.
- BURN, R. 1971. Comment on the proposed addition to the official list of *Okenia* Menke, 1830 and *Idaliella* Bergh, 1881. Bulletin of Zoological Nomenclature 28:141-142.
- CATTANEO-VIETTI, R., R. CHEMELLO & R. GIANNUZZI-SAVELLI. 1990. Atlas of Mediterranean Nudibranchs. La Conchiglia: Rome. 264 pp.
- CERVERA J. L., P. J. LÓPEZ-GONZALEZ & J. C. GARCÍA-GÓMEZ. 1991. Taxonomic and geographical range data on two rare species of *Okenia* (Gastropoda: Nudibranchia: Doridacea) from the eastern Atlantic. The Veliger 34:56-66.
- DALL, W. H. 1908. Reports on the Mollusca and Brachiopoda (of the Albatross in the Eastern Pacific during 1891, 1904, and 1905). Bulletin of the Museum of Comparative Zoology 43:205-531. pls 1-22.
- D'ORBIGNY, A. 1835-1846. Voyage dans l'Amérique Méridionale exécuté pendant les années 1826-1833. Vol. 5. Mollusques. Libraire de la Société géologique de France: Paris. 758 pp. plus Atlas.
- GOSLINER, T. M. 1987. Nudibranchs of Southern Africa. Sea Challengers: Monterey, California. 136 pp.
- GOULD, A. A. 1852. United States exploring expedition during the years 1838-1842. Mollusca and Shells. U.S. Exploring Expedition 12:i-xv, 1-510, plus Atlas, 1856.
- JUST, H. & M. EDMUNDS. 1985. North Atlantic nudibranchs (Mollusca) seen by Henning Lemche. Ophelia (Suppl.) 2:1-150.
- LESSON, R. P. 1831. Voyage autour du monde exécuté par ordre du roi sur la corvette de sa majesté, La Coquille, pendant les années 1822, 1824 et 1825. Zoologie 2(1):239-455.
- MACNAE, W. 1958. The families Polyceridae and Goniodorididae (Mollusca, Nudibranchiata) in southern Africa. Transactions of the Royal Society of South Africa 35:341-372. pls. 17, 18.
- MARCUS, E. 1957. On Opisthobranchia from Brazil (2). Linnean Society of London Zoological Journal 43:390-486.
- MARCUS, E. 1959. Lamellariacea und Opisthobranchia. Reports of the Lund University Chile Expedition 1948-49. Acta Universitatis Lundensis N.F. (2) 55:1-133.
- MARCUS, E. & E. MARCUS. 1967. Some opisthobranchs from Sapelo Island, Georgia, U.S.A. Malacologia 6:199-222.
- ODHNER, N. H. 1921. Mollusca from Juan Fernández and Easter Island. Pp. 219-254, pl. 8-9. In: C. Skottsberg (ed.), Natural History of Juan Fernández and Easter Island. Vol. 3. Almqvist & Wiksell: Uppsala.
- SCHMEKEL, L. 1979. First record of *Okenia impexa* Marcus, 1957 from the Western Atlantic in the Mediterranean. The Veliger 21:355-360.
- SCHMEKEL, L. & A. PORTMANN. 1982. Opisthobranchia des Mittelmeeres. Nudibranchia und Saccoglossa. Springer Verlag: New York. x + 410 pp.
- THOMPSON, T. E. 1988. Molluscs: Benthic Opisthobranchs (Mollusca: Gastropoda). Synopses of the British Fauna (new ser.) no. 8 (2nd ed.). E. J. Brill/Dr. W. Backhuys, The Bath Press: Avon. 356 pp.